

Allow MF4 for photonuclear data

Current format

File 4 is used to describe the angular distribution of emitted particles. It is used for reaction with incident neutrons only and should not be used for any other incident particle.

The double differential cross section is given as

$$\frac{d\sigma(E)}{dE'd\Omega} = \frac{d\sigma(E)}{2\pi dE'd\mu} \equiv \frac{\sigma(E)}{2\pi} P(E', \mu|E)$$

where E is the incident particle energy, E' is the outgoing particle energy and μ is the outgoing scattering cosine. Here, $\sigma(E)$ is the integrated (“total”) cross section and $P(E', \mu|E)$ is the probability density for an emitted particle to have outgoing energy E' and outgoing cosine μ .

If the reaction in question has two body kinematics, than we may write

$$P(E', \mu|E) = P(\mu|E)\delta(E' - E'(\mu))$$

Alternatively we may assume that the energy and angle parts of the distribution are uncorrelated. In that case we have

$$P(E', \mu|E) \approx P(\mu|E)P(E'|E)$$

In either case, MF4 is used to store $P(\mu|E)$. The ENDF manual uses the function $f(\mu, E)$ instead of $P(\mu|E)$.

Current use

The MF4 format is used for outgoing neutron distributions in both the neutron sublibrary and the photonuclear sublibrary. In the case of the photonuclear library, MF4 is used for outgoing neutron distributions for MT=16, 18 and a few other MT's for ^{232}Th , ^{233}U , ^{234}U and several other evaluations. ***Strictly speaking, ENDF forbids use of MF4's for photonuclear data.***

Proposed rule change

Formally, the only restriction to the use of $P(\mu|E)$ above is in the very first equation: an integrated cross section $\sigma(E)$ must exist for the process in question. Therefore the use of MF4 for charged particle scattering is mathematically eliminated due to the Coulomb singularities. The ENDF MF6 format provides workarounds and procedures for charged particles. ***However, MF4 could still be used for incident photon data.*** In fact, as we mentioned above, it is already in use in ENDF's photonuclear library. Therefore, we propose to remove the restriction on the use of MF4 for incident photon data.

Changes to the ENDF manual

- 0.4.3.2, 4th paragraph: “For incident neutrons” becomes “For incident neutrons and photons”
- 0.4.3.3, 4th paragraph: “incident neutron sublibrary” becomes “photonuclear and incident neutron sublibraries”
- 4.1, 1st paragraph: “incident neutrons” becomes incident neutrons and photons”
- 4.1, 7th paragraph: “incident neutron energy” becomes “incident energy”